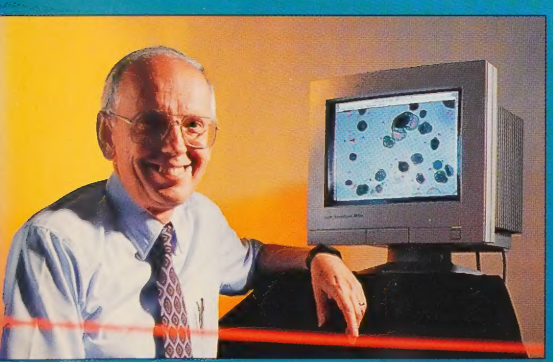
Changing the way we live and work



mrco

The Manufacturing Research Corporation of Ontario

1993/94 Annual Report

Ontario Centres of Excellence

MISSION STATEMENT

The Manufacturing Research Corporation of Ontario (MRCO) supports industrial innovation in Ontario by facilitating the timely and effective transfer of technological advances from the research community to the manufacturing sector.

MRCO directly funds and manages fundamental research at Ontario universities. The corporation sponsors research projects which are relevant to industrial needs. MRCO also helps manufacturers find research expertise to develop applied technology solutions to manufacturing problems.

Innovations in advanced technology are required to ensure the future competitiveness of Ontario manufacturers in international markets. By bridging the gaps between manufacturers and the research community, MRCO contributes to the development of an innovative, R&D-driven, industrial culture in Ontario.

VOCATION DE LA SOCIÉTÉ

La Société de Recherche Manufacturière de l'Ontario (SRMO) appule toute innovation industrielle dans la province en facilitant de façon efficace et opportune le transfert àl'industrie manufacturière de tout progrès technologique réalisé par la communauté des chercheurs.

SRMO finance directement et gère la recherche de base effectuée dans les universités ontariennes. La Société finance aussie des projets de recherche ayant trait aux besoins de l'industrie. SRMO aide enfin les manufacturiers à trouver des experts-chercheurs pouvant apporter des solutions technologiques aux problèmes de l'industrie manufacturière.

Les innovations dans la technologie avancée sont nécessaires si l'on veut qu'à l'avenir les fabricants ontariens solent concurrentiale sur les marchés internationaux. En combiant le fossé qui existe entre les manufacturiers et la communauté des chercheurs, SRMO contribue à l'essor d'une cuiture industrielle vouée à la recherche et au développement.

TECHNOLOGY ONTARIO
Technology Ontario was established in 1986 to enhance Ontario's national and international industrial competitiveness.

This objective is achieved through technological innovations requiring increased collaborations between Ontario's industries, universities and research institutions.

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Front cover:
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Spot welding at General Motors in Oshawa, Ontario.

Bottom
Professor Steve Balke, an MRCO/OCMR (Ontario Centre for Materials Research) researcher, is shown with samples of extruded plastic blends along with an in-line monitor image of the material in the extruder.

CHAIRMAN'S REPORT

Manufacturing is at the forefront of economic change and wealth creation in North America. In Ontario, a robust manufacturing base is critical to ensure future economic growth and stability. We must recognize that manufacturing is the foundation for creating sustainable employment. It generates the investment that leads to innovation and economic growth.

A recent Bank of Canada study noted that manufacturing productivity is growing slower in Canada than in other industrialized countries. A key reason for this is that manufacturing industries that use advanced technologies to produce their goods have much higher productivity growth than those who do not. This category accounts for approximately 35 per cent of manufacturing in Canada, compared to 50 per cent for some of our industrial competitors. If Canadian manufacturers had made more use of advanced technology, productivity in Canada would have increased by at least 1/4 percentage point per year from the mid-1980s on.

For Ontario manufacturing to survive and succeed in the future, we must continue to focus on improving productivity by aggressively investing in state-of-the-art production processes and in the skills required to develop and maintain them.

Manufacturers in the province are now taking steps to meet the economic challenges of the 1990s, however, they cannot succeed on their own. Manufacturers need assistance from organizations like the Manufacturing Research Corporation of Ontario (MRCO) to work with them to encourage innovation, entrepreneurship, product investment and industrial growth.

MRCO, one of Ontario's seven Centres of Excellence, continues to support advanced manufacturing research at a number of Ontario universities. Through the Centre's innovative industrial programs, manufacturers are realizing substantial improvements in their operations.

RAPPORT DU PRÉSIDENT DU CONSEIL

Le domaine de la fabrication est au premier plan des changements économiques et de la création du patrimoine en Amérique du Nord. En Ontario, un secteur manufacturier fort est essentiel à la croissance et à la stabilité économique de la province. Il importe donc de reconnaître que le domaine de la fabrication est à la base de la création d'emplois stables et que c'est lui qui encourage les investissements qui mènent à l'innovation et à la croissance économique.

Une étude récente menée par la banque du Canada démontrait que la productivité du secteur manufacturier est plus faible au Canada que dans les autres pays industrialisés. La principale raison, c'est que les industries manufacturières qui utilisent des technologies de pointe pour fabriquer leurs produits connaissent une croissance de productivité plus forte que celles qui ne le font pas. Au Canada, seulement 35 p. 100 environ des industries utilisent des technologies de pointe par rapport à 50 p. 100 de leurs concurrents. Si les fabricants canadiens avaient davantage utilisé les technologies de pointe, la productivité au Canada aurait augmenté d'au moins 1/4 de 1 p. 100 par année depuis le milieu des années 80.

Si nous voulons assurer la survie et le succès du secteur manufacturier de l'Ontario, nous devons continuer à mettre l'accent sur l'amélioration de la productivité en investissant davantage dans les technologies de pointe en fabrication et dans les compétences requises pour les développer et les maintenir.

Les fabricants de la province prennent présentement des mesures afin de relever les défis économiques des années 90, cependant, ils ne peuvent y arriver seuls. Ils ont besoins de l'appui d'organismes tels la Société de Recherche Manufacturière de l'Ontario (SRMO) pour stimuler l'innovation, l'esprit d'entreprise, les investissements dans les produits et la croissance industrielle.

La SRMO, un des sept centres d'excellence de l'Ontario, continue à appuyer la recherche de pointe en fabrication dans plusieurs universités ontariennes. Grâce aux programmes industriels novateurs du Centre, les fabricants ont remarqué une amélioration sensible de leurs activités.

For example, in 1993 MRCO launched a collaborative research initiative. The objective of this initiative is to directly link the research needs of industry with the capabilities of university researchers with the ultimate goal of stimulating advances which contribute directly to Ontario's wealth creation.

MRCO also contributes to Ontario's manufacturing base by transferring knowledge and technology from MRCO-sponsored university research projects to small and medium-sized manufacturers. In 1993/94, several companies accessed leading-edge, home-grown technology which assisted them in their quest to remain competitive.

The Centre's Board of Directors regularly discuss key issues and make decisions that reflect MRCO's commitment to responding to the needs of Ontario manufacturers and to furthering the Centre's mission. On behalf of MRCO's management, I would like to thank all members of the Board for their dedication over the past year. A listing of the Board is noted below.

Improving our competitiveness by utilizing advanced manufacturing technologies is critical to our success in the international marketplace. As we enhance our manufacturing capabilities in Ontario, we will generate the wealth required to create employment and sustain our standard of living. MRCO will continue to assist and support this change.

W. J. McClean

Mr. William J. McClean
Chairman - MRCO

Par exemple, en 1993, la SRMO s'est lancée dans la recherche concertée dont l'objectif était d'assortir les besoins en recherche des entreprises aux capacités chercheurs des universités afin de faire progresser la recherche qui bénéficierait directement à la création du patrimoine de l'Ontario.

La SRMO contribue également au secteur manufacturier ontarien en transférant la technologie et les connaissances des universités qu'elle parraine aux petites et moyennes entreprises. En 1993-1994, bon nombre d'entreprises ont utilisé de la technologie de pointe développée au pays afin de demeurer concurrentielles.

Le conseil d'administration du Centre traite régulièrement de sujets importants et prend des décisions qui reflètent bien l'engagement de la SRMO à répondre aux besoins des fabricants ontariens et à promouvoir la mission du Centre. Au nom de la direction de la SRMO, je tiens à remercier tous les membres du conseil de leur dévouement au cours de la dernière année. Vous trouverez ci-après la liste des membres du conseil.

Notre succès sur le marché international dépend de l'amélioration de notre compétitivité grâce à l'utilisation des technologies de fabrication de pointe. Au fur et à mesure que nous améliorerons notre capacité de production en Ontario, nous contribuerons au patrimoine nécessaire à la création d'emplois et à la conservation de notre niveau de vie. La SRMO poursuivra ses efforts pour encourager le transfert de technologie.

BOARD OF DIRECTORS

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IBM Canada Limited

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Executive Director and President
Canadian Manufacturers' Association (CMA)

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PRESIDENT'S REPORT

The Manufacturing Research Corporation of Ontario (MRCO) remains dedicated to serving the technological needs of the manufacturing sector, a vital segment of Ontario's economy. By contributing to the essential transition of manufacturing to an innovation and knowledge-based, high value-added and customer driven industry, MRCO has positioned itself as an important component of the research and development infrastructure in the province.

The competitiveness and indeed the survival of Ontario-based manufacturing companies depends on the investments they make in advanced technologies, workforce training, total quality management, increasing operating efficiencies, and reducing production costs. MRCO's innovative research and industrial programs have been designed to assist manufacturers and academics in their role of contributing to the economic and social well-being of Ontario.

MRCO's *SME Outreach Program* was launched in 1993 and is targeted at technologically progressive small and medium-sized manufacturers. The results of this initiative have exceeded expectations. Originally conceived as an MRCO-only program, it has been expanded to include five other sponsoring R&D organizations.

The Centre's *Collaborative Research Program* is a new initiative introduced in 1993. Research projects developed under this program involve partnerships between companies, MRCO and university researchers and require joint planning, shared funding and participation in the research. These projects are designed to deliver specific benefits to the parties involved.

RAPPORT DU PRÉSIDENT

La Société de Recherche Manufacturière de l'Ontario (SRMO) continue à répondre aux besoins, sur le plan technologique, du secteur manufacturier, un élément important de l'économie ontarienne. En aidant les entreprises de fabrication à devenir des entreprises axées sur l'innovation, les connaissances, la valeur ajoutée et la satisfaction des clients, la SRMO jour un rôle primordial dans le domaine de la recherche et du développement de la province.

La compétitivité ainsi que la survie des enterprises manufacturières de l'Ontario dépendent des investissements qu'elles font dans les technologies de pointe, la formation de la main-d'oeuvre, la gestion de la qualité totale, l'amélioration de l'efficacité de l'exploitation et la réduction des coûts de production. Les programmes industriels novateurs de la SRMO ont été conçus de manière à aider les fabricants et les universités à assumer leur rôle en tant que participants au bien-être économique et social de l'Ontario.

En 1993, la SRMO a lancé un programme visant à établir des liens avec des petites et moyennes enterprises techniquement avancées. Les résultats de cette initiative ont dépassé toutes les attentes. En effet, étant du départ la propriété exclusive de la SRMO, ce programme est maintenant parrainé par cinq autres organismes qui se consacrent àla recherche et au développement.

Le programme de recherche concerté du Centre est un autre programme qui a été créé en 1993. Les projets de recherche élaborés dans le cadre de ce programme prévoient des partenariats entre des enterprises, la SRMO et des chercheurs des universités, et impliquent une planification conjointe, un financement partagé et une recherche collective. Ces projets sont conçus de manière à procurer des avantages bien particuliers aux participants.

Dans le but de permettre à la SRMO de mieux promouvoir et faire valoir les capacités des universités ontariennes dans le domaine de la recherche en fabrication, la Centre a récemment créé une base de données de plus de 200 chercheurs, qui n'étaient pas déjà parrainés par la SRMO, qui ont la capacité et la volonté de faire de la recherche au profit des fabricants ontariens.

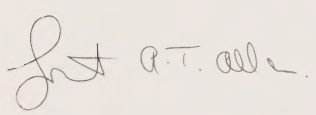
In an effort to enhance MRCO's expertise to market and to represent the full breadth of the manufacturing research capability in Ontario universities, the Centre recently created a database of over 200 researchers, not previously supported by MRCO, who indicate a capability and willingness to conduct research for the benefit of Ontario manufacturers.

To date, MRCO's *Ontario University Research Capabilities Database* has already united over a dozen manufacturers with research experts who can help their company.

For further information on these and other innovative programs, please refer to the ***Centre Initiatives*** section of this report.

MRCO's Board of Directors and Senior Advisory Committee share a broad awareness of the commercial and research and development environment in Ontario and continue to provide strong strategic guidance. The Finance Committee and Executive Committee met, at the discretion of the Board, to address critical strategic issues of importance to the Centre.

MRCO is committed to the vital importance of the manufacturing sector in the future economic development of the province. The Centre has an increasingly important role to play in ensuring that the partnerships between Ontario universities and its manufacturing base contribute to the overall growth and well being of the province.



Dr. Grant A.T. Allan
President - MRCO

À ce jour, la base de données des capacités de recherche des universités ontariennes de la SRMO a déjà rassemblé plus d'une douzaine de fabricants comptant des chercheurs capables de venir en aide à leur entreprise.

Pour obtenir de plus amples renseignements sur ces programmes ainsi que sur d'autres programmes novateurs, veuillez vous reporter à la section intitulée ***Centre Initiatives*** dans ce rapport.

Le conseil d'administration ainsi que le comité consultatif supérieur de la SRMO se tiennent au fait de ce qui passe dans le domaine de la recherche et du développement en Ontario et continuent de prodiguer leurs conseils. Le comité des finances et le comité exécutif se sont réunis, à la demande du conseil d'administration, afin de traiter des points importants pour le Centre.

La SRMO s'emploie à faire valoir l'importance du secteur manufacturier dans le développement économique de la province. Le Centre a un rôle de prime importance àjouer pour assurer que les partenariats entre les universités ontariennes et le secteur manufacturier contribuent à assurer la croissance économique générale et le bien-être de la province.

REVIEW OF OPERATIONS

INTRODUCTION: RESEARCH PROGRAM

During the fiscal year 1993/94, MRCO's research program evolved from primarily an academically-sponsored portfolio of projects to a balance of industry-driven and academically-sponsored research projects.

Academically-sponsored projects originate by university-based researchers, normally in response to a request for proposals by MRCO. These projects do not require initial funding from industry but are designed to attract and ultimately lead to industry participation. Traditionally, these projects have a life-span of three years or greater.

Industry-driven or collaborative research projects are created from an identified technology need of an Ontario manufacturer(s). The industry partner must provide significant cash and in-kind contribution to the project, and deliverables must be clearly identified and received by the industrial participant(s). Typically, these projects are completed within a one to three year period.

Currently, 60% of MRCO's funding capacity for the next five years has been allocated to academically-sponsored projects. This allows for an emerging industry-driven component consisting primarily of consortia and collaborative projects.

Over the 1993/94 fiscal year, MRCO distributed approximately $3.6 million in academically-sponsored research funding among the following academic institutions: Carleton University, McMaster University, Queen's University, University of Guelph, University of Toronto and the University of Waterloo. These projects were managed by 29 principal investigators and were organized under four theme areas: intelligent control, plastic processing, metal processing and production systems.

On the following pages, MRCO highlights a number of successsful and exciting research initiatives. These entreprises, along with other MRCO-supported projects, have the potential to realize significant benefits to the Ontario manufacturing sector.

ACADEMIC RESEARCH PROGRAM: DR. VALERIE DAVIDSON

Dr. Valerie Davidson, a principal investigator for MRCO at the University of Guelph, is part of a team of faculty and graduate students at the School of Engineering who are focusing their research efforts on the control of biological systems and processes, including food manufacturing. The process control group, including Drs. Ralph Brown, Gordon Hayward, and Lambert Otten, along with Dr. Davidson, spearhead the MRCO project **"Development of Quality-Driven Control Systems for Food Processes"**. Dr. Davidson was recently interviewed about the project.

MRCO: The processes you are studying - roasting peanuts and drying grain - seem very low-tech. Please explain how food processing can indeed benefit from the very sophisticated research techniques you are using.

Dr. Davidson: These two examples may appear to be simple, but both illustrate some of the characteristics that make computer-based control of food processes different from the control of other manufacturing operations. Biological systems are inherently difficult to control, as amateur winemakers quickly discover when they try to produce a consistent vintage from batch to batch.

Drying and roasting are both common unit operations in the food processing industry and are simply two different examples we have chosen to demonstrate our control software. We have been able to set up a small-scale operation in our R&D lab where we can run experiments and test the control software yet not worry about failures (i.e., making large amounts of off-spec product). This type of testing and demonstration is not feasible on a production line.

The Ontario food industry needs to introduce more sophisticated, computer-based control to improve productivity and remain competitive. However, the food industry in general has lagged behind other manufacturing industries and manual, operator-based control is still the norm. The benefits of our control system are more consistent control and assistance for operators when dealing with complex systems.

MRCO: How do food processing operations differ from say, metal processing or plastics processing, and why is conventional computer-based control not adequate for many food processes?

Dr. Davidson: Some elements are common because the same operations such as mixing, extruding, and extraction are found in all of these industry sectors. However, the food processor uses raw materials that are complex in terms of composition and physical characteristics, and changeable, depending on factors such as supplier, maturity and growing season. During processing operations like heating and drying, biopolymers and other molecules in food systems undergo complex physical and chemical transformations. The processor's objective is to produce a consistent, high quality product which the consumer ultimately judges based on subjective factors such as appearance and taste.

As a result, it is often difficult to measure on-line the key chemical and physical properties that relate to product quality yet operators can make reasonable judgements about attributes such as the roasted colour or the degree of cook.

The control software that we are developing uses numeric inputs from simple sensors as well as linguistic inputs from operator observations to make inferences about the state of the process and the need for control action. The control strategy must recognize how changes in a process variable such as drying temperatures affect not only moisture removal but also flavour, texture and functional properties like water absorption. Since some of these effects cannot be defined in mathematical models, we use an expert system approach.

MRCO: What other food processes can your research be applied to?

Dr. Davidson: The software is being developed in a modular format so that components can be adapted for a range of different operations in the food industry. The roasting control system for peanuts could be modified for other roasting operations such as coffee and cocoa beans. Drying is common to many food processes such as breakfast foods, dried fruits, and pasta products. Any new application requires some software modification because the actual control algorithms are process-specific. However, the definition of linguistic variables and fuzzy values, the logic operations, and the inference engine are generic components that would be used in all applications.

MRCO: How will you make the results of this project available to industry, and is the food processing industry sophisticated enough to be able to utilize your research results?

Dr. Davidson: One of the reasons for building a pilot-scale operation was to enable us to conduct demonstrations for potential industrial users. We are planning our first workshop for December, 1994, and participants will get "hands on" experience with the control system software.

While the control system is capable of sophisticated decision-making, the interface that the operator works with will be easily understood. This is one of the advantages of fuzzy data representation which accepts linguistic information.

MRCO: We understand that your project is receiving industrial support from an Ontario-based company called Dantec Systems Corp. Please explain your relationship with this company.

Dr. Davidson: Dantec has developed the Dryer Master system for on-line moisture measurement and computer-based control of drying processes. Dantec is interested in learning more about our fuzzy techniques and comparing the performance of our control system for drying to their Dryer Master. We are now installing a Dryer Master system on our pilot scale unit which we purchased from Dantec at a price substantially below the market value. In return Dantec engineers will work with our group to learn about fuzzy process control and possibly to expand the potential of their control system

Drs. Lambert Otten, Ralph Brown, Valerie Davidson and Gordon Hayward (left to right) watch as roasted peanuts flow from the discharge auger of the pilot plant roaster. The researchers are using the pilot-scale processing system to develop and demonstrate control systems for food and biological processes.

ACADEMIC RESEARCH PROGRAM: DR. MOHAMED ELBESTAWI

Dr. Mohamed Elbestawi of McMaster University, an MRCO principal investigator since the inception of the Centres program, was recently awarded an NSERC Industrial Chair for research in precision machining valued at $1.69 million over five years. This highly prestigious award is given by the Natural Science and Engineering Research Council (NSERC) to assist Canadian universities in expanding or launching major new research endeavours significant to Canadian industry. The dollar value of the awards is substantially higher than that of typical research grants from NSERC or other research funding groups.

To be eligible for this NSERC program, the research activity involved must be in the field of natural sciences and engineering; an industrial partner must be willing to financially support the activity; and the recipient of the chair must hold a senior administrative position in a Canadian university.

Dr. Elbestawi readily met all the criteria. He is a full professor with internationally recognized expertise in precision machining, and not just one, but seven industrial partners are contributing financially to his research program. These companies - GM Canada, Hayes-Dana Inc., Liburdi Engineering Ltd., Westinghouse Canada, Husky Injection Molding Systems, Fabris Manufacturing and Sensors Adaptive Machines Inc. - will contribute a total of $425,000 over the five-year program. MRCO, also a participant in the project, will contribute $175,000.

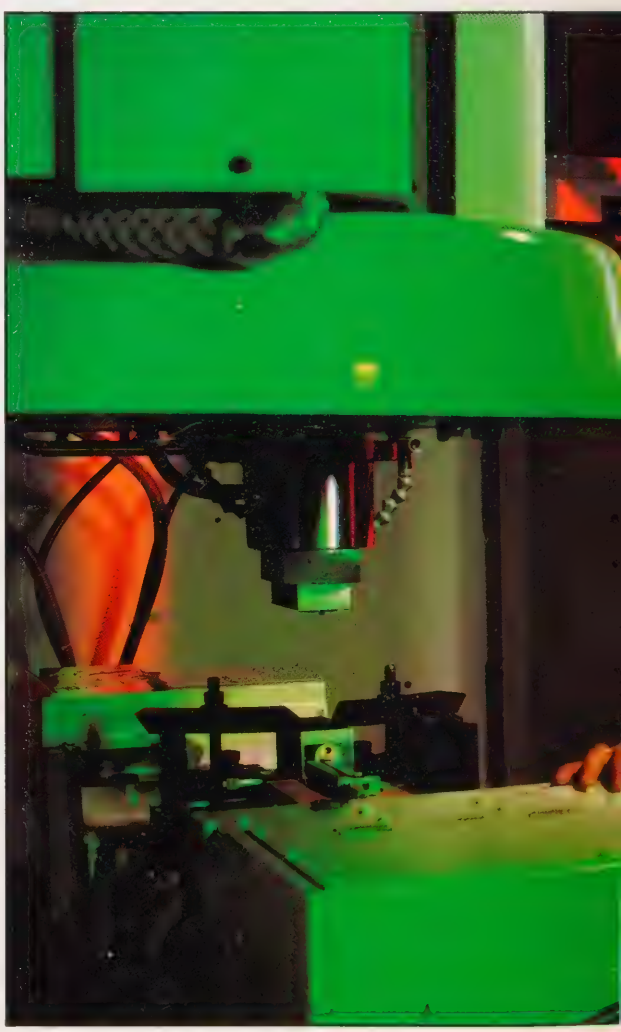
In a recent conversation with Dr. Elbestawi, we asked him to elaborate on the meaning of precision machining, and this is his response.

"Precision machining implies accuracy of the machined product to required specifications. Clearly, the accuracy of the finished product is of major importance because of economic, safety and durability reasons.

"During the machining process, such as turning a shaft on a lathe, for example, a number of variables could affect the final accuracy of the machined part. Such variables might be vibrations and deflections during cutting, tool wear, and expansion of the part due to heat. Precision machining requires the development of technologies to ensure the accuracy of the product despite the presence of these inevitable variables."

"These technologies, " he explained, "deal with improving and optimizing the performance of present day machine tools by adding state-of-the-art sensing and control devices which can identify and minimize the inaccuracies during cutting. An important consideration is also to operate the machine tools under conditions which result in maximum accuracy. This implies understanding the mechanics of the cutting operation itself as well as the effect of the type of material being machined."

A strong research program in Manufacturing Engineering began at McMaster University in the early 1970s. Over the years, the program has gained an international reputation for its activities in the area of machining systems. The philosophy of this machining research program at McMaster has always been very practical and industrially oriented.



Since the Chair award is intended to benefit both the university and Canadian industry, we asked Dr. Elbestawi to describe what he viewed as the benefits for each party. Here are his comments.

"The establishment of the NSERC Chair will significantly improve the capabilities of machining research at McMaster through the addition of new faculty members, graduate students, research engineers and technicians. In addition, improvements to the laboratory facilities are being achieved through the acquisition of new and state-of-the-art machine tools and sensing equipment.

"As a result of these expanded capabilities," he went on, "new research areas will be created which deal with issues of major importance to the Canadian manufacturing industries. Examples of these new areas include die and mold manufacturing and laser machining."

Professor Mohamed Elbestawi is shown beside his state-of-the-art 5-Axis Precision Machining Centre. This newly purchased machine will be used extensively throughout the duration of his NSERC Industrial Chair research program.

Dr. Elbestawi pointed out that a substantial increase to the industrial relevance of machining research at McMaster is made possible because of the expanded capabilities. "These improved capabilities will also have a positive impact on the overall scientific quality of the research programs, as well as the education and training of graduate students and engineers. The importance of these qualified engineers to Canadian industry cannot be over-emphasized."

There are some specific areas which will be targeted by the Chair-funded research. We asked Dr. Elbestawi to highlight them and describe their value to industry in Ontario and Canada. He outlined three of these areas below.

"The development of intelligent, advanced machine tool controllers will have a significant impact on the productivity and competitiveness of all manufacturers who are users of Computer Numerical Controlled (CNC) machine tools. The anticipated improved performance of present-day machine tools will result in higher accuracy levels in machining the finished products, as well as higher metal removal rates."

Dr. Elbestawi anticipates that overall productivity could be increased by 10% to 30% depending on the type of cutting operation, and decreases of cutting time and savings in tool changing time could be achieved.

The second area is in the development of advanced Computer Aided Manufacturing (CAM technologies for sculptured surfaces. "This development will have an important beneficial impact to the manufacturing of dies and molds used in automobiles aerospace and mold cavities," he says. "The benefits will be achieved through a shortened product cycle and generally improving the economics of manufacturing."

"A third area," he went on, "is research related to machinability of hard materials and non-conventional cutting methods. This work will result in improved know-how for the metal removal industries with important gains in competitiveness, productivity and machining costs."

COLLABORATIVE RESEARCH PROGRAM: VULCAN-VULCAP INDUSTRIES LTD.

When Vulcan-Vulcap, a manufacturer of tire retread and repair equipment, developed a new ultrasonic technology capable of simply and efficiently inspecting tires and tire casings for defects, they helped revolutionize the retreading industry. Vulcan's patented Ultrasonic Tire Casing Analyzer provides a non-destructive method of tire inspection that is reliable and user-friendly. Moreover, all forms of tire defects including nail holes, belt separations, inner liner separations, retreading separations and casing defects can be identified and located.

Although ultrasonic technology is now widely accepted by the industry, it is not without its limitations. Currently, skilled operators are required to mount each tire and adjust a system of sensors accordingly. Through ultrasonic transmitters and receivers the Casing Analyzer helps the operator decide whether a tire can be retreaded or has to be discarded. Unfortunately, this task is extremely laborious and somewhat subjective.

In an effort to address these issues, MRCO recently introduced Mr. Heinz Haischt, president and general manager of Vulcan-Vulcap to University of Toronto professor Andrew Goldenberg. Now a collaborative research project supported equally by MRCO, Vulcan and Engineering Services Inc., a spin-off company from the University of Toronto specializing in industrial automation and robotic turnkey systems, will develop an intelligent controller based on a robotic end-effector that will carry the ultrasonic sensors.

This controller will regulate the sensing operation, provide autonomous positioning and guidance of the end-effector, and fine tune the sonic parameters so that defects can be detected and evaluated reliably.

Mr. Haischt recently responded to a number of questions concerning his new and improved Ultrasonic Tire Casing Analyzer technology.

MRCO: How important/beneficial is this new technology to the tire and retreading industry?

Mr. Haischt: For many years, the tire industry has been searching for a non-destructive, simple and productive way to inspect tires and tire casings for flaws. Good casings are presently being discarded and are being disposed of in landfill sites much to the detriment of the environment. On the other hand, labour and effort is often expended by buffing and preparing a tire for retreading only to discover that the casing has major irreparable flaws.

This new technology will eliminate a great degree of human error and will result in significant savings of time and cost associated with retreading. This product will ultimately provide the retreading industry with a strong competitive advantage.

MRCO: Is there a potential to export this product?

Mr. Haischt: Currently, our equipment is exported to over 40 different countries worldwide and has an extensive dealer network. The majority of the Ultrasonic Tire Casing Analyzers (95%) will be exported.

MRCO: What level of expertise, if any, will be required to operate this new technology?

Mr. Haischt: We have devoted a tremendous amount of effort in the design of the Casing Analyzer to ensure that it will operate fully automatically. No expertise will be required. The advanced technology simplifies the analysis of any tire regardless of tread depth, design or wear pattern. The colour computer graphics zoom in on defects and the sizes of flaws to be rejected are preprogrammed into the machine. A print out of the tire condition will be provided automatically.

MRCO: How will you test the new product when it's completed?

Mr. Haischt: Ideally, the completed machine will be tested in a local tire retreading shop for several months and will then be introduced at The American Retreaders' Association Tire Show in Louisville, Kentucky.

MRCO: What specifically attracted Vulcan to the University of Toronto research capability?

Mr. Haischt: The robotics department at the University of Toronto has a proven track record of developing robotic solutions for industrial applications. The research team is focussed and solution oriented, rather than just academically research oriented.

MRCO: Please comment on the benefits of MRCO's Collaborative Research Program and its value in helping realize this project.

Mr. Haischt: MRCO's Collaborative Research Program is action oriented, flexible and directed to the needs and interest of industry. As a small company with limited resources, the majority of our funds were spent in getting the machine to a prototype stage. We were not financially able to finalize the ultrasonic and automatic robotic sub-system.

We were able to prove that the system worked and obtain a U.S. patent, but we did not have the resources to bring the machine to the production prototype stage. MRCO's Collaborative Research Program was just the help we needed to move to the next stage of this important invention and as a result Vulcan-Vulcap will substantially increase it's sales worldwide and create employment opportunities

Mr. Heinz Haischt stands before various sizes of commercial tires at Vulcan-Vulcap Industries Ltd., his tire retreading plant located in Scarborough, Ontario.

COLLABORATIVE RESEARCH PROGRAM: REKO TOOL & MOULD INC.

Why do you decide to get into manufacturing? There are many reasons — but usually when you can serve the marketplace with a good product at the right price and profit level.

Sounds simplistic, but this was the case for Mr. Steve Reko, owner and president of Reko International Inc. The company designs and manufacturers injection moulds and other industrial tools, namely dies, fixtures, vacuum form moulds, models and special machines. The company's operating subsidiaries, Reko Tool & Mould Inc. and Tri-Mi Mould Inc., produce the injection moulds.

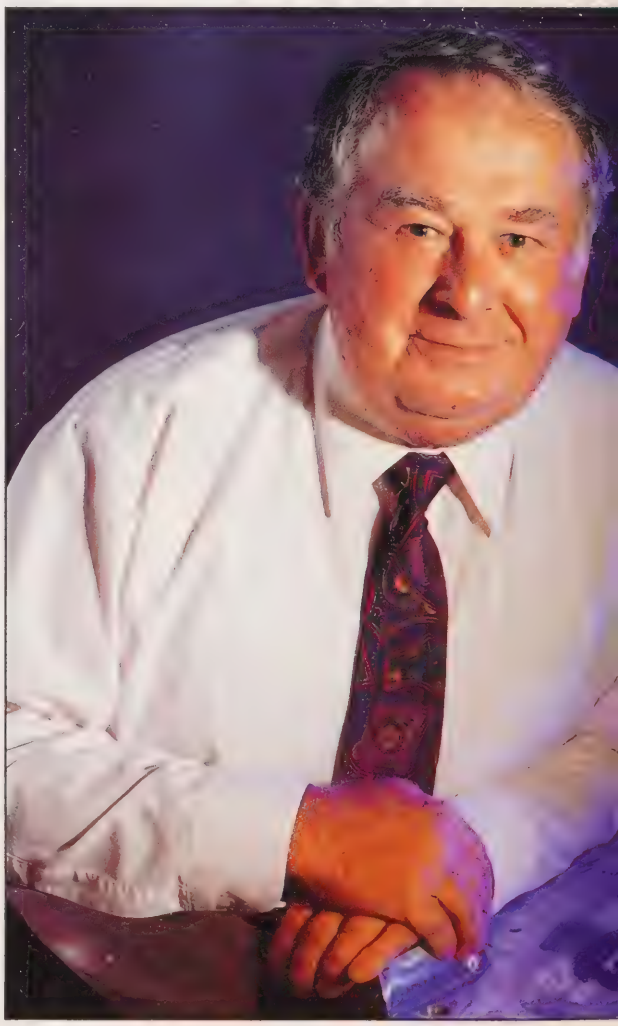
Roughly 72% of the company's sales come from suppliers who manufacture automobiles, light trucks and vans, with the remainder from suppliers of consumer products such as microwave ovens, refrigerators and dishwashers. Recently, Reko began manufacturing moulds for suppliers of basins, vanities, outdoor lawn furniture and lawn tractors.

It is estimated that in North America alone the annual market for injection moulds is about $2.0 billion. Over the last decade, suppliers have been subjected to intense competitive pressure from foreign and North American competitors.

Reko has responded to these demands by developing and successfully implementing advances in design, manufacturing techniques and technology. These advancements permit Reko to dramatically decrease the process time for the design and the production time for the manufacture of its injection moulds while maintaining the high quality of its products

For example, Reko was quick to embrace and adopt the application of CAD/CAM techniques to the injection moulding process. Now, CAD/CAM systems have become the life-line of the die and mould industry. Typically, CAD systems are used to create a design while CAM systems are used to assist in machining operations. Unfortunately, these programs currently require a great deal of human intervention and operate at a modest efficiency level.

Professor Ruxu Du, Assistant Professor in the Department of Industrial Engineering at the University of Windsor, has the perfect solution to these challenges. Professor Du first became acquainted with MRCO several years ago when he was a graduate student of MRCO-funded Professor Mohamed Elbestawi of McMaster University.



Professor Du will team his expertise and resources with MRCO's and Reko's financial support to develop an intelligent CIM system for the machining of dies and moulds. This collaborative research project will combine currently available CAD/CAM systems with a knowledge-based computer-aided process planning module.

This enhancement will ultimately allow machining plans, including the selection of machines, tools, machining sequence, cutting conditions and cutter path, to be automatically created based on a part design. The result will be minimized machining time and machining cost as well as the verification of CNC codes through computer simulation before execution.

Mr. Steve Reko is shown beside a Beta 2405 Coordinate Measuring Machine (CMM) located at his plant in Windsor, Ontario. Among other things, this machine accurately inspects details and surfaces of injection moulds, fixtures and master models.

And unlike current commercial CAD/CAM systems, this technology is an intelligent system that will deliver maximum production with minimum human interaction. It is a turn-key system with a user-friendly interface for complete operator master control. It is also expected that by adopting this enhanced system, NC programming time will be reduced by 80% and machining time by 10%.

For Steve Reko this technology will allow his company to "...streamline our existing system and allow us to reduce lead times, as well as eliminate a number of steps in production. He continues, "The benefits to the tool and mould industry are numerous. In addition to ensuring faster response time, the productivity of CAD/CAM personnel will increase dramatically. This will ultimately result in a strong competitive advantage for the industry."

In addition to the benefits that this technology will bring to industry, Ontario's academic community will also reap rewards. The financial support provided by Reko and MRCO will allow the University of Windsor to employ a post-doctoral fellow and three graduate students to work specifically on this collaborative project over the next eighteen months.

As for MRCO's innovative Collaborative Research Program, Steve Reko applauds the Centre for developing an action driven program directed at the needs of industry. He elaborates, "Reko needs all the help we can get! With MRCO's financial assistance and the resources at the University of Windsor, we can achieve results that will take us to a higher plateau in manufacturing."

TECHNOLOGY TRANSFER PROGRAMS

Over the past several years, MRCO has evolved into a needs-driven organization that targets its resources to programs that assist Ontario's manufacturing sector remain on the cutting-edge. This enhanced focus has resulted in the creation of a multitude of university-industry linkages, the building of alliances with other research and development organizations and the broadening of the resource base for the support of research in Ontario universities.

One of the mechanisms that the Centre has established to facilitate collaboration among manufacturers and universities is the research consortia. MRCO's *Consortia Program* is dedicated to bringing like-minded organizations together to solve a particular manufacturing issue. This approach immediately delivers bottom-line, profitable results to each member company.

For example, MRCO's Foundry Group Consortium, lead by Professor John Goldak at Carleton University, has developed software that accurately simulates the pouring, filling and solidification of a casting and predicts where metallurgical defects are likely to occur.

For Rob Parsons, supervisor of manufacturing at Haley Industries Limited and a consortia member, this was exactly the technology that they were looking for. He explains, "Over the past few years our customers have been demanding shorter development lead times and reduced development costs. These demands enticed us to join MRCO's Foundry Group Consortium."

Haley and the other members of the consortia recently took receipt of the software. Mr. Parsons elaborates, "We're extremely pleased with the results of the analyses performed to-date. These programs will significantly reduce the time required to develop a perfect first-time casting."

Formtech Inc., an MRCO-managed consortia, received a powerful endorsement in early 1994 from the Government of Ontario. The project, now in its second phase, was granted $3.6 million by Dr. Richard Allen, Ontario Minister responsible for International Trade.

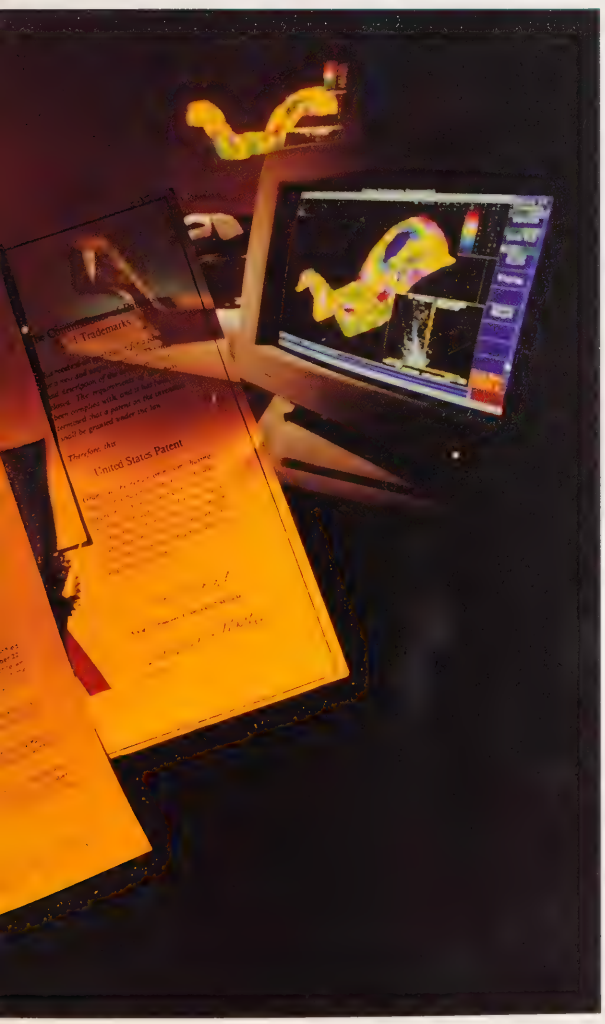
Formtech II consortium members include steel makers Stelco Inc. and Dofasco Inc., and metal stampers Hayes Dana Inc., A.G. Simpson Ltd., BMG North America, National Auto Radiator and the Rover Group. Forming Technologies Inc. is the primary R&D resource for the project with Carleton, McMaster, Sherbrooke and Waterloo universities also contributing to the research.

Formtech II will undertake collaborative R&D of computer-aided engineering programs for sheet metal stamping for the automotive parts sector and other users of stamped products.

Roughly 37 new jobs will be created by the consortia project which will invest $7.2 million over four years, including cash and in-kind contributions of facilities and engineering expertise by the consortium members.

To date, over 40 companies have participated in consortia developed by MRCO, and as a result of these consortia a total of $9.7 million of industry support has been secured to university-based research.

A number of MRCO-secured patents are featured in the forefront. The background image illustrates one of the computer-based engineering programs developed by the MRCO-managed Formtech Consortium.



MRCO believes strongly that a necessary strategy for competing in an increasingly global environment is an investment in human resources. A vital part of the Centres mandate is to support the training of highly-skilled, manufacturing-oriented graduate students associated with MRCO's research projects.

The total number of students trained and supervised by MRCO researchers has increased substantially from an annual level of 100 to approximately 400 over the life of the Centre. Over 80% of these students are finding employment in Canada, either in industry, research establishments or academia.

Another successful mechanism for technology transfer is the delivery of patents and licenses. During 1993/94, close to a dozen patents have been filed and over eight licenses have been secured. These technologies include: plastics processing, seamtracking for robotic welding, laser positioning for robotic welding, robotic positioning for ultrasonic sensors, 3-D vision system, computer integrated manufacturing software and intelligent weight/measure system.

The above methods of technology transfer to industry represent a tremendous opportunity for wealth creation. By adopting and applying home-grown technology, Ontario's progressive manufacturing companies can successfully compete in international markets.

CENTRE INITIATIVES

In keeping with MRCO's philosophy of being a needs-driven organization, the Centre launched a number of new directed initiatives during the fiscal year 1993/94.

MRCO's *SME Outreach Program* is a targeted campaign to reach Ontario's technologically progressive small and medium-sized manufacturers. The program's recipe for success consists of three key elements: targeting progressive threshold manufacturing firms; one-on-one discussions with company CEO's and senior managers; and, focussing the discussion on the research and development needs of the company.

Due to the initial success of the program, MRCO has expanded the resource base to include five other participating research and development organizations. By 1995, over 150 manufacturing companies will have had significant and meaningful interactions with the resources made available through the program.

MRCO's *Collaborative Research Program* is a new initiative introduced in 1993 designed to reflect the needs-driven focus of the Centre, and MRCO's goal to enhance the cash and in-kind participation of industry to manufacturing-oriented academic research.

All collaborative projects relate directly to the industrial partners' business. The project must be leading-edge and demonstrate new science and technological innovation. Manufacturers associated with the program are achieving commercial success in terms of bottom-line profitability, lasting change, productivity improvements, and competitive new products. In addition, this initiative contributes to the training of highly skilled industry-oriented students associated with MRCO's academically-sponsored research projects.

In an effort to uncover the research capabilities in Ontario universities, MRCO recently created a database of over 200 researchers not previously associated with the Centre. These researchers have indicated a capability and desire to perform research for the benefit of Ontario manufacturers.

Since the development of MRCO's *Ontario Research Capabilities Database*, over a dozen manufacturers have been coupled with research experts who can help their company.

Innovative, entrepreneurial companies contribute significantly to Ontario's job and wealth creation. By assisting in the commercialization of technology that has resulted from a number of MRCO-sponsored research projects, the Centre has contributed to the development of a number of spin-off companies.

Ms. Joanna Blair, an MRCO administrative assistant, reviews the Centre's *Ontario Research Capabilities Database*. This database contains over 200 surveys of researchers with a keen interest in conducting research for the benefit of Ontario manufacturers.

For example, **Engineering Services Inc.** is currently transforming itself from a technology development services firm to a manfacturer of robotic and automation systems serving the manufacturing sector. **Virtek Vision Corp.**, a spin-off from the University of Waterloo, develops and manufacturers vision intelligence robotics technologies for a variety of industrial applications.

And, **Powerlasers Inc.** offers the latest in innovative laser technologies with a focus on laser welding of aluminum/magnesium alloys for application in the automative industry.

During 1993/94, MRCO tapped its pool of experienced researchers to present seminars, workshops and short courses for the benefit of industrial partners. These informative sessions create the groundwork for the continued exchange of knowledge and know-how between industry participants and MRCO researchers.

By accessing these innovative programs, Ontario's manufacturers and researchers alike are equipped with technological advances that this province needs to generate the wealth required to sustain our standard of living, and guarantee an enhanced quality of life for future generations of Ontarians.

COMMUNICATIONS PROGRAM

In its purest terms, communications can be described as the transmission or exchange of ideas and information. The mark of a strong, effective communications program is one that delivers ideas and information in the form of news rather than advertising.

MRCO believes that this effective communication is essential to the success of the Centre's programs and initiatives. MRCO's directed and aggressive communications programs continues to focus on three key thrusts: a component which builds awareness of the Centre, its mandate and capabilities; a targeted approach to specific sectors and industries likely to be receptors of MRCO's services; and, continuous contact with existing industrial partners in order to optimize networking opportunities and partnerships in new Centre endeavours.

In an effort to convey a concise, consistent image of MRCO, a series of communication tools have been developed including a corporate brochure, networks/consortia kit, licensing opportunities pamphlet, executive summaries of MRCO's research projects, annual report, corporate video and a trade show exhibit.

In 1993, the Centre introduced the *R&D Link* newsletter. This quarterly report highlights successes in Ontario universities and in the manufacturing sector in an informative and to-the-point manner. The newsletter, which reaches an audience in excess of 600, will remain a primary vehicle used to communicate to MRCO's stakeholders.

Print media also remains a important tool by which to communicate to the broader public. In 1993/94, MRCO's successes and programs were noted in Plant Newspaper, Machinery & Metalworking Magazine, Burlington Spectator and Research Money, just to name a few.

MRCO also recognizes the importance of communications for the entire Centre of Excellence Program. A major element of MRCO's communications strategy is cooperative efforts in the Centre's joint communications program. This program is devoted to building an overall awareness of the Centre program, its successes and new endeavours.

The joint communications program has developed a series of communication tools, an effective trade show exhibit and recently launched an aggressive communications strategy.

Once again in 1993, MRCO in association with the Ontario Centre for Materials Research (OCMR), designed and produced a curriculum resource booklet for Ontario science teachers. To date, the series consists of two booklets focusing on the theme "From the Lab to the Marketplace", with another book under development for 1994.

MRCO believes that these innovative initiatives will present valuable benefits by developing linkages between Ontario's academic community, Ontario manufacturers and the province's educators.

APPENDIX 1

COMMITTEE MEMBERSHIP 1993/94

SENIOR ADVISORY COMMITTEE

Dr. Derek McCammond
Chairman of Mechanical Engineering
University of Toronto

Mr. Nick K. Befanis
Director, OPS Planning and Services
Northern Telecom Canada Limited

Dr. Bill Lennox
Professor of Civil Engineering
University of Waterloo

Dr. Mamdouh Shoukri
Professor of Mechanical Engineering
McMaster University

Dr. Grant Allan
President
MRCO

Mr. Paul Belluz
Manager, PCCS Finance and Planning
IBM Canada Ltd.

Dr. Paul Cohen
Director of Marketing and Business Dev.
Celestica Inc.

Mr. Ed Cinits
Director, Technology Transfer
MRCO

Mr. Mike J. Powell
Administrator, Manufacturing Planning and Sales
General Motors of Canada Limited

FINANCE COMMITTEE

Dr. Clare Beingessner
Vice President, Engineering
B & W Heat Treating (1975) Limited

Dr. Les C. McLean
President
Steltech Ltd.

Dr. Ron Childs
Vice President Research
McMaster University

EXECUTIVE COMMITTEE

Mr. William J. McClean
Vice President of Manufacturing and Development
IBM Canada Limited

Dr. Ron Childs
Vice President Research
McMaster University

Dr. Clare Beingessner
Vice President, Engineering
B & W Heat Treating (1975) Limited

APPENDIX 2

MANUFACTURING RESEARCH CORPORATION OF ONTARIO
RESEARCH EXPENDITURES REPORT

Year Ended 31/03/94

University	Researcher	Expenses	Project Title
1) McMaster	Elbestawi, M.	$ 173,900	Open Architecture Manufacturing
		$ 51,100	Ultrasonic Sensor
		$ 6,300	NSERC Industrial Chair
	Dokainish, M.	$ 97,100	Stress Analysis of Brazing and Rolling
	Marlin, T.E.	$ 71,000	Plant-Wide Control of Product Quality & Equipment Performance & Profit
	Vlachopoulos, A.	$ 200,900	Computer-Aided Plastics Processing
	TOTAL:	$ 600,300	
2) Queen's	Browse, R.A.	$ 139,800	Enhanced Display & Control Techniques for Intelligent Automation & Manufacturing
	Ellis, R.E.	$ 97,400	Automated Diagnosis of Failures in Robot Joints
	McAuley, K.B.	$ 135,600	Product Property Modelling for Polyethylene and Polypropylene Polymerization
	TOTAL:	$ 372,800	
3) Carleton	Goldak, J.	$ 327,800	Castings Design and Analysis
	TOTAL:	$ 327,800	
4) Waterloo	Wong, A.	$ 330,100	Vision and Knowledge-Based Robotics and Integrated Manufacturing
	Wilson, W.	$ 81,800	Direct End-Point Control of Assembly Robots Using Integrated Sensors
	Vannelli, A.	$ 60,700	Large-Scale Optimization Approaches for Cellular Manufacturing
	Lawless, J.	$ 41,000	Statistical Methods for Analysis & Control of Reliability
	Wu, C.F.J.	$ 98,500	Quality Improvement & Variation Reduction via Experimental Design and Process Control
	Yovanovich, M.	$ 62,100	Development of Conjugate Thermofluid Models and Algorithms for CAD/CAM Microelectric Component and Systems
	Duley, W.W.	$ 97,300	Expert CO2 Laser Welding System
	Huissoon, J.P.	$ 234,700	Control of Robotic Welding
	Lenard, J.G.	$ 156,400	Microstructure Control During Hot Strip Rolling
	Moore, J.B.	$ 45,000	Improved Planning and Control in Ontario Manufacturing
	TOTAL:	$ 1,207,600	

APPENDIX 2 Cont'd

University	Researcher	Expenses	Project Title
5) Toronto	Goldenberg, A.	$ 241,900	High Performance Robotic Activators
	Woodhams, R.	$ 235,700	Manufacture of Self-Reinforced Plastics
	Turksen, I.	$ 95,800	Fuzzy Logic Based Intelligent Management Systems
	Turksen, I.	$ 252,300	Fuzzy Logic Based Processor Design
	Meguid, S.A.	$ 146,300	Mechanics of Shot Peening
	Menzinger, M.	$ 127,700	Differential Flow Induced Chemical Instability (DIFICI)
	Park, C.	$ 14,700	Synthesis and Analysis of Polymer/Water Solutions in Microcellular Plastics Production
	Spelt, J.K.	$ 84,800	Development of a Comprehensive Design Methodology for Adhesive Joints
	Fox, M.S.	$ 180,700	Distributed Management of Supply Chain Functions
	Mandelis, A.	$ 93,800	Laser-Based Photothermal Non-Destructive Evaluation
	Venter, R.D.	$ 66,600	Development Projects within Ontario Industry
	TOTAL:	$ 1,540,300	
6) Guelph	Davidson, V.J.	$ 70,300	Development of Quality Driven Process Control System for Food Process
	TOTAL:	$ 70,300	
TOTAL FOR ALL UNIVERSITIES ×:		$ 4,119,100	
	Bridge Financing ○:	$ 124,200	

× This amount does not include :

$300,000 in research expenses to Carleton University for the Canadian Die Cast Consortium
$8,400 to Dr. Waguih ElMaraghy, University of Western Ontario

○ These funds, paid from April 1, 1993 to June 30, 1993 supported students whose MRCO projects were not renewed at the start of the new 5-year period.

APPENDIX 3

Schedule G: Baseline Data

Education

Area	Base	1988	1989	1990	1991	1992	1993
1. Total no. of graduate students registered	107	203	253	320	444	M: 330 F: 47	M: 251 F: 46
2. Number of above with Visa	N/A	N/A	N/A	80	125	106	69
3. Number of students leaving	N/A	N/A	N/A	71	97	86	59
4. Number of students to industry	22	30	44	65	55	62	36
5. Number of students to industry in Ontario	N/A	N/A	N/A	55	50	61	32
6. Number of students to university positions	N/A	N/A	N/A	14	31	20	16

Publications

Area	Base	1988	1989	1990	1991	1992	1993
1. Number of refereed publications	320	259	317	394	466	389	298
2. Number of patents	12	1	2	10	16	10	15
3. Number of invited papers and lectures	133	147	179	206	216	180	165
4. Number of technology licenses to industry	0	1	3	11	14	3	28

Industry Support

Area	Base	1988	1989	1990	1991	1992	1993
1. Industry funding to researchers	418,899	2,578,692	3,369,163	4,884,175	2,678,538*	2,507,767	2,274,187
2. Industry funding in-kind to support researchers	N/A	N/A	N/A	582,000	1,564,000*	572,000	631,500
3. In-kind funding by industry to Centre mgmt	N/A	50,000	130,000	300,000	52,000	20,000	48,600
4. Membership fees to the Centre	N/A	0	0	0	149,000	120,000	54,430

Government Support

Area	Base	1988	1989	1990	1991	1992	1993
1. NSERC	2,019,146	2,567,676	3,004,873	2,983,097	3,261,649*	3,522,281	2,645,899
2. Other Federal	131,333	70,200	362,200	1,247,232	1,119,676	1,371,250	1,410,779
3. Ontario (not Centres)	172,800	988,598	1,095,623	1,643,896	1,439,564	1,027,364	506,140
4. Other Government	246,000	643,960	1,026,000	1,111,500	1,021,378	1,529,694	262,919
5. Foundations, etc.	92,666	80,000	127,400	51,900	101,000	20,000	362,000

Communications / Technology Transfer

Area	Base	1988	1989	1990	1991	1992	1993
1. Number of person days of company employees attend workshops/seminars	N/A	381	472	788	428	541	1,002
2. Number companies in a working relationship with Centre investigators:							
a) Chair Support	0	2	2	2	3	5	33
b) Research interactions	47	97	128	160	246	195	184
c) Contacts	13	23	33	53	371	250	318
d) Consulting fees	8	14	33	39	51	39	91
e) Grant & Donations	14	12	17	23	46	25	92

*Numbers have been verified and corrected accordingly.

1991 and 1992 data reflects the impact of a number of research projects reaching completion as well as the effects of the economic climate.

APPENDIX 4

AUDITORS' REPORT
March 31, 1994
To the Members of the
Manufacturing Research Corporation of Ontario

We have audited the balance sheet of the Manufacturing Research Corporation of Ontario as at March 31, 1994 and the statement of income, expenses and change in fund balance for the year then ended. These financial statements are the responsibility of the corporation's management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with generally accepted auditing standards. Those standards require that we plan and perform an audit to obtain reasonable assurance whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation.

In our opinion, these financial statements present fairly, in all material respects, the financial position of the corporation as at March 31, 1994 and the results of its operations and the changes in its financial position for the year then ended in accordance with generally accepted accounting principles.

Ernst & Young

Mississauga, Canada,
May 10, 1994.

Chartered Accountants

APPENDIX 4 Cont'd
Manufacturing Research Corporation of Ontario [Incorporated under the laws of Ontario]

BALANCE SHEET

As at March 31

	1994	1993
	$	$
Assets		
Cash	**33,954**	3,604
Funds on deposit [note 3]	**1,416,446**	1,121,370
Accounts receivable	**146,145**	160,518
Due from University of Waterloo interest	**6,823**	7,993
Prepaid rent	**2,443**	1,907
Fixed assets [note 5]	**4,478,601**	4,530,333
	6,084,412	5,825,725
Liability, Equity and Fund Balances		
Accounts payable	**1,239,266**	787,539
Due to Formtech Inc. [note 4]	**–**	160,700
Equity in cumulativecapital expenditures [note 5]	**4,478,601**	4,530,333
Fund balance	**366,545**	347,153
	6,084,412	5,825,725

See accompanying notes

On behalf of the Board:

Director

Director

APPENDIX 4 Cont'd

Manufacturing Research Corporation of Ontario

STATEMENT OF INCOME, EXPENSES AND CHANGE IN FUND BALANCE

Year ended March 31

	1994 $	1993 $
Income		
Government grants [note 2]	5,818,520	6,461,989
Research contracts [note 7]	212,821	318,161
Interest income	99,710	105,042
	6,131,051	6,885,192
Expenses		
Disbursements to universities:		
Salaries and benefits	2,227,712	2,752,828
Overhead	1,067,999	1,557,959
Direct operating	765,425	816,677
Capital	498,344	297,561
Total university expense	4,559,480	5,425,025
Administration:		
Saleries and benefits	842,121	812,005
Direct operating	489,791	557,927
Unrecovered expenses [note 9]	192,000	–
Capital	28,267	17,022
Total administration expenses	1,552,179	1,386,954
	6,111,659	6,811,979
Increase in fund balance from operations	19,392	73,213
Increase in fund balance from BadenWurttemberg project [note 8]	–	1,452
Increase in fund balance	19,392	74,665
Fund balance, beginning of year	347,153	272,488
Fund balance, end of year	366,545	347,153

See accompanying notes

NOTES TO THE FINANCIAL STATEMENTS

March 31,1994

1. Summary of significant accounting policies and reporting practices

The Manufacturing Research Corporation of Ontario ["the Centre"] was incorporated on December 24, 1987 under the laws of Ontario as a not-for-profit corporation. The aim of the Centre is to foster long-term advanced research in manufacturing by universities and industry, and thus to enhance both knowledge and application of technology in order to help insure the future research and industrial competitiveness of the Province of Ontario in a global context. This research is performed in a cooperative venture between post-secondary educational institutions and industry. The Centre is managed independently of the universities and industries which have created, and are participating in, the work of the Centre.

The following summarizes the significant policies followed by the Centre:

Fund accounting

The accounts of the Centre have been maintained in accordance with the principles of fund accounting in order that limitations and restrictions placed on the use of available resources may be observed.

Accrual accounting

The accrual basis of accounting is followed whereby research and other expenses are recorded when incurred, and revenues when collected or when collection is virtually certain.

Capital expenditures

Equipment purchases are expensed in the period in which payment is made. The cumulative original cost of fixed assets, for which the Centre retains ownership, less any disposals, is recorded on the balance sheet; equity in cumulative capital expenditures is recorded to the extent that acquisitions are currently funded or debt incurred for such expenditures has been retired.

2. Funding of the Centre

The Province of Ontario made grants to the Centre of $31,000,000 over the five-year period January 1, 1988 to December 31, 1992. The province approved additional funding of not more than $32,750,000 over a further five-year period, commencing January 1, 1993. Effective October 1, 1993, this amount was reduced to $28,200,000 for the five-year period. The grants are to be provided quarterly, in accordance with the business plan submitted by the Centre. During the fiscal period ended March 31, 1994 the Centre received $5,818,520.

Future funding from the Province of Ontario is contingent upon the Centre meeting certain criteria. Funding has been approved as follows:

	$
Received to December 31, 1992	31,000,000
Received from January 1, 1993 to March 31, 1994	7,308,720
Subsequent funding schedule	
March 31, 1995	5,733,660
March 31, 1996	5,609,960
March 31, 1997	5,534,160
December 31, 1997	4,013,500
	59,200,000

The amount of the unexpended portion of the Provincial grants which may be utilized in any subsequent operating period shall not exceed the following:

End of operating period	% of period allocation
March 31, 1994	10
March 31, 1995	10

The amount for periods ending March 31, 1996, March 31, 1997 and December 31, 1997 will be determined by the Province of Ontario at a future date.

3. Funds on Deposit

Funds on deposit are held by the University of Waterloo on behalf of the Centre. The University of Waterloo pays the Centre interest at the average monthly rate of return earned on the University's short-term investments.

APPENDIX 4 Cont'd
Manufacturing Research Corporation of Ontario

NOTES TO THE FINANCIAL STATEMENTS Cont'd

4. Management Contracts

The Centre manages the business affairs of Formtech Inc., an industry consortium formed to conduct research in the field of metal stamping. In return for this service the Centre was paid a management fee of $27,452 which is reflected in revenue from research contracts.

5. Cumulative Capital Expenditures

All equipment or other assets purchased with any part of the Provincial grants, for the period January 1, 1988 to December 31, 1992, is the property of the Centre. Upon termination of the Centre or if the agreement with the Government of Ontario is terminated prior to December 31, 1997, the ownership of the assets transfers to the Government of Ontario. Participants in the Centre shall have an option to acquire the assets at fair market value at that time. Cumulative capital expenditures have been recorded at original cost which does not necessarily reflect fair market value.

Equipment or other assets purchased with any part of the Provincial grants, for the period January 1, 1993 to December 31, 1997 shall be the property of the University and are not recorded as cumulative capital expenditures on the balance sheet.

6. Contract Research - University

The Centre subcontracts research performed on its behalf to faculty members of the universities of Toronto, Western, Waterloo, McMaster, Queens, Carleton and Guelph. Funds are disbursed to the universities to cover salaries expense, reimbursement to participating universities for the cost of incremental personnel directly involved and working in the research programme of the Centre, and the costs to purchase release time from teaching duties in order to free additional time for personnel to dedicate to the programme. Amounts are dispensed for expenditures in each of these areas based on budgets approved in advance by the Centre. Overhead is charged at a rate of 65% for the months of April to September and a rate of 50% for the remainder of the year of salaries and benefits by the participating universities; such charge is meant to recover both the general university costs of the research programme, and the incremental cost of providing general infrastructure support at the academic unit level. Academic units of the universities are required to utilize one-half of the overhead charge for general university costs and one-half for payment of academic unit costs.

7. Research Contracts - Industry

The Centre enters into research contracts with the corporate sector including both individual companies and industry consortia.

8. Baden-Wurtttemberg Project

The Manufacturing Research Corporation of Ontario entered into an agreement with the Province of Ontario effective January 1, 1990 which stated that the Province was to provide additional funding to the Manufacturing Research Corporation of Ontario in the amount of $690,000 over a 3 year period ended December 31, 1992. This funding was used for the Computer-Aided Process Planning/Production and Control Integration Project which had as its major objective the improvement in the implementation of Computer Integrated Manufacturing. The research was conducted in conjunction with the Fraunhofer Institute for Production Automation of the State of Baden-Wurttemberg, Germany. The agreement between the Fraunhofer Institute for Production Automation and the State of Baden-Wurttemberg was similar to the agreement between the Manufacturing Research Corporation of Ontario and the Province of Ontario and was for the same amount. Technology transfer took place between the two companies, but no funds were transferred. All funding for this project had been received by December 31, 1992.

The increase in fund balance from Baden-Wurttemberg Project is determined as follows:

	1994	1993
	$	$
Income		
Government grants	8,010	172,710
	8,010	172,710
Expenses		
Salaries and benefits	5,465	101,067
Overhead	1,331	62,499
Direct operating	1,214	7,692
	8,010	171,258
Increase (decrease) in fund balance from Baden-Wurttemberg Project	—	1,452

APPENDIX 4 Cont'd
Manufacturing Research Corporation of Ontario

NOTES TO THE FINANCIAL STATEMENTS Cont'd

9. Unrecovered Expenses

Unrecovered expenses represent reimbursable expenses which may not be recovered.

10. Commitments

The Centre is committed to annual rental payments for office space of approximately $62,000. The current lease expires on December 31, 1997.

As at March 31, 1994, the Centre was committed to operating and capital expenditures in the amount of $52,574.

11. Statement of Cash Flows

A statement of cash flows has not been included in these financial statements as it is not considered to provide additional meaningful disclosure.

12. Comparatives

Certain comparative figures have been restated to conform with presentation adopted in the current year.

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